



The composition of human milk is highly variable and tailored to the nutritional needs of the baby. Recent studies show that the composition of human milk ranges throughout breastfeeding stages, varies over the course of one feeding, depends on the gender of the infant, follows mother's diet and lifestyle, and adapts to the infant's health and development status.

HUMAN MILK COMPOSITION IS HIGHLY VARIABLE BOTH WITHIN AND BETWEEN WOMEN. SOME OF THIS VARIABILITY IS AN AUTOMATIC ADAPTATION TO THE CHANGING INFANT NEEDS

BREASTFEEDING STAGES

The composition of human milk varies throughout the different breastfeeding stages. The human milk produced immediately after birth is called *colostrum*. This milk is characterized by being low in volume yet rich in constituents beneficial to the immune system. During the *transitional stage*, fat and lactose content increase, while the amount of protein and prebiotics decreases [1]. After approximately 15 days the human milk has substantially increased in volume and is called

mature milk. During the maturation of human milk, there is also a change in individual human milk oligosaccharides (HMOS). The gradual change in composition throughout lactation matches the infant's developmental state [2].

OVER THE COURSE OF ONE FEEDING

Interestingly, human milk is not constant: its composition changes over the course of just one feeding session [3-9]. The major change in human milk composition, during a single feeding, is in the proportion of fat. *Foremilk* is thin, watery, low in fat and contains important carbohydrates, proteins and vitamins. *Hindmilk*, on the other hand, is thick, creamy and high in fat [10-12].

INFANT'S HEALTH STATUS

Human milk reflects the health status of the infant. There is emergent evidence that the levels of immune cells in human milk increases in case of an infant becoming infected by pathogens. This means that immune modulatory constituents change in *response to active infection* of the infant [13,14].

Did you know that kangaroos produce different milks from distinct teats, each adapted to the needs of her babies of different life stages [28]

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GENDER

Recent studies found human milk from mothers of boys having 25% greater caloric content than from mothers of girls, as least in wealthy families. This is supporting faster growth in newborn boys [15-18].

SEASON AND CLIMATE

The composition of human milk can vary in different environments and different seasons. The water content can adapt to fulfill the liquid demands of an exclusively breastfed baby even in hot and dry environments [19]. Also, the amount of anti-pathogenic compounds in milk of women from different regions has been linked to infant pathogen risks associated with the specific environment [20]. Furthermore, distinct constituents of human milk, such as vitamin D or immune components, seem to vary depending on seasonal factors [21,22].

MOTHER'S GENES

The composition of human milk is influenced by regulation of thousands of genes, making up approximately one quarter to one third of the total number of genes contained in the genome. A substantial part of worldwide variability in the quantity and quality of human milk components, like lipids and prebiotics, is linked to the genetic differences between mothers [23-27].

MOTHER'S DIET

Studies show that mother's diet, even during pregnancy, can influence the human milk

composition during breastfeeding. The maternal intake of several vitamins, minerals, a certain quantity and quality of fat are linked to the composition of human milk [28,29]. For example, some studies indicate a link between fish consumption and amounts of DHA in human milk. Other studies show a positive correlation between dietary vitamin C and human milk concentrations of vitamin C. Optimizing the maternal diet during pregnancy and lactation is important, not only to provide the baby with the best possible nutritional to start for growth and immediate health, but to induce positive health effects that can last a baby's whole life [29,30].

CULTURE AND LIFESTYLE

Maybe unknown to herself, a great part of variability in human milk composition is influenced by a mother's way of interacting with the environment and the culture of her social group. For example, family, friends or local culture often determine how a mother breastfeeds. The readout of many genes involved in lactation is directly or indirectly influenced by cues from external and social environments. For example, the spacing and duration of feedings is as diverse as people's general lifestyles. This culturally determined behaviour influences the constitution of human milk, such as fat, energy or water content [31-33].

Human milk composition is influenced by a mother's way of interacting with the environment and by the culture of her social group [32,33]

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